

WHAT IS CLAIMED IS:

1. A positive electrode material of substituted lithium nickel-manganese oxides for a non-aqueous lithium cell, comprising a composition of $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{M}'_\delta\text{O}_{2-z}\text{X}_z$ ($\text{M}' = \text{Mg, Zn, Al, Ga, B, Zr, Ti}$; $\text{X} = \text{F, S, Cl, I}$), wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0 and 0.333, δ is between about 0 and 0.2, and z is between about 0 and 0.5.
2. The positive electrode material of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{O}_{2-z}\text{F}_z$, and wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, and z is between about 0 and 0.5.
3. The positive electrode material, of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{O}_{2-z}\text{F}_z$, and wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0.01 and 0.333, and z is between about 0 and 0.5.
4. The positive electrode material, of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Al}_\delta\text{O}_{2-z}\text{F}_z$, and wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, δ is between about 0.01 and 0.2, and z is between about 0 and 0.5.
5. The positive electrode material of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Ti}_\delta\text{O}_{2-z}\text{F}_z$, wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, δ is between about 0.01 and 0.2, and z is between about 0 and 0.5.

6. The positive electrode material of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{Al}_\delta\text{O}_{2-z}\text{F}_z$, and wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0.01 and 0.333, δ is between about 0.01 and 0.2, and z is between about 0 and 0.5.

7. The positive electrode material of claim 1, wherein the composition comprises $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{Ti}_\delta\text{O}_{2-z}\text{F}_z$, and wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0.01 and 0.333, δ is between about 0.01 and 0.2, and z is between about 0 and 0.5.

8. The electrode material of claim 1, wherein the electrode material is formed by a solid state reaction process.

9. The electrode material of claim 1, wherein the electrode material is formed by an aqueous solution based process.

10. The electrode material of claim 1, wherein the electrode material is formed by a sol-gel process.

11. The electrode material of claim 9, wherein the electrode material prepared by the steps of:

dissolving appropriate amounts of lithium hydroxide, lithium fluoride, nickel hydroxide, cobalt hydroxide, and M'-hydroxide or M'-nitrate; M' = Mg, Zn, Al, Ga in distilled water whose pH was adjusted with nitric acid to form a first solution;

adding an aqueous solution of manganese acetate to the first solution to form a second solution;

refluxing the second solution in a flask attached with a condenser at about 80°C for about 12-24 hours;
evaporating the second solution in a rotary vacuum evaporator to form a gel precursor;
eliminating organic contents from the gel precursor at about 400°C for about 2 hours to form a powder; and
calcining the powder at about 900-1000°C for about 10-24 hours in either an air or an oxygen containing atmosphere.

12. The electrode material of claim 10, wherein the electrode material prepared by the steps of:

dissolving appropriate amounts of lithium acetate, lithium fluoride, nickel acetate, manganese acetate, cobalt acetate, and M'-acetate or M'-nitrate; M' = Mg, Zn, Al, Ga in distilled water to form a first solution;
added the first solution to a glycolic/tartaric acid solution that is used as a chelating agent to form a second solution;
adjusting the pH of the second solution to about 7 using ammonium hydroxide, resulting in a gel precursor;
decomposing the gel precursor at about 450°C for about 5 hours in air to form a decomposed power; and
firing the decomposed powder at about 900-1000°C for about 10-24 hours in an air or an oxygen containing atmosphere,
wherein the dissolving, adding, and adjusting steps occur under continuous stirring and heating.

13. The electrode material of claim 9, wherein the electrode material is prepared by the steps of:

mixing appropriate amounts of lithium hydroxide (or lithium carbonate), lithium fluoride, (Ni,Mn,Co)-hydroxide [or (Ni,Mn,Co)-carbonate], M'-hydroxide (or M' oxide; M' = Mg,Zn,Al,Ga,B,Zr,Ti);

calcined the mixed materials at about 450~550°C for about 12-30 hours in air; and

calcining the mixed materials at about 900-1000°C for about 10-24 hours either in air or in an oxygen-containing atmosphere.

14. A non-aqueous lithium cell comprising:

a negative electrode;

a non-aqueous electrolyte; and

a positive electrode,

wherein the positive electrode has a composition of $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{M}'_\delta\text{O}_{2-z}\text{X}_z$ (M' = Mg,Zn,Al,Ga,B,Zr,Ti; X = F,S,Cl,I), wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0 and 0.333, δ is between about 0 and 0.2, and z is between about 0 and 0.5, and wherein x, α , β , γ , δ , and z are controlled so as to fix the oxidation states of Ni, Mn, and Co as Ni^{2+} , Mn^{4+} , and Co^{3+} , respectively.

15. A positive electrode material made of substituted lithium nickel-manganese oxides for non-aqueous lithium cell, comprising:

a composition of $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{M}'_\delta\text{O}_{2-z}\text{X}_z$

(M' = Mg,Zn,Al,Ga,B,Zr,Ti; X = F,S,Cl,I), wherein x, α , β , γ , δ , and z are controlled so as to fix the oxidation states of Ni, Mn, and Co as Ni^{2+} , Mn^{4+} , and Co^{3+} , respectively.

16. A positive active material for a secondary lithium cell, comprising:

a core comprising at least one composition of $\text{Li}_{1+x}\text{Ni}_\alpha\text{Mn}_\beta\text{Co}_\gamma\text{M}'_\delta\text{O}_{2-z}\text{X}_z$ ($\text{M}' = \text{Mg, Zn, Al, Ga, B, Zr, Ti}$; $\text{X} = \text{F, S, Cl, I}$), wherein x is between about 0 and 0.333, α is between about 0.2 and 0.6, β is between about 0.2 and 0.667, γ is between about 0 and 0.333, δ is between about 0 and 0.2, and z is between about 0 and 0.5; and

either a surface layer or a surface phase on the core, comprising at least one surface coating material from a coating material source selected from the group consisting of alkoxides, hydroxides, oxides and mixtures thereof,

wherein the surface-coated compound is heat-treated to form hydroxides or amorphous oxides on the compound surface.

17. The positive active material of claim 16, wherein the amount of the surface coating material source is between about 0.05 and 10 percent by weight based upon the weight of the positive active material.

18. The positive active material of claim 16, wherein the coating element of the surface coating material source comprises at least one element selected from the group consisting of Al, Bi, Ga, Ge, In, Mg, Pb, Si, Sn, Ti, Tl, Zn, Zr.

19. The positive active material of claim 18, wherein the surface coating material source comprises Al-isopropoxide, zinc methoxide or indium-isopropoxide and is dissolved in ethanol.

20. The positive active material of claim 16, wherein the heat-treating process is carried out at a temperature ranging from about 100 to 500°C for a duration ranging from about 1 to 24 hours.